American Dream Delayed:  
Shifting Determinants of  
Homeownership*  

Natalia Khorunzhina†  
Robert A. Miller‡  

April 1, 2019  

Abstract  
This paper develops and estimates a dynamic model of discrete  
choice for labor supply, fertility and transition from tenant to home  
owner, to investigate the secular decline in homeownership over the  
past several decades, wholly attributable to households postponing the  
purchase of their first home. Housing prices only partly explain the  
decline; higher base level wages led to lower fertility also contributing  
to the decline, because households with children are more likely to own  
a home than those without. Somewhat surprisingly we find higher lev-  
els of female education ameliorated this trend, highly educated women  
placing greater value on home ownership.  

KEYWORDS: Housing Demand, Fertility, Labor Supply.  

JEL: R21, J13, J22, D14, D91  

*We would like to thank Orazio Attanasio, and seminar participants at Carnegie Mellon  
University, Copenhagen Business School, the University of New South Wales, University  
of Melbourne as well as participants of Zeuthen workshop on The Life Cycle Model of  
Individual Choices for helpful comments. All errors are our own.  
†Department of Economics, Copenhagen Business School, Porcelænshaven 16A, 2000  
Frederiksberg, Denmark, e-mail: nk.eco@cbs.dk.  
‡Tepper School of Business, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh,  
PA 15213, USA, e-mail: ramiller@cmu.edu.
1 Introduction

The average age of a first-time home buyer increased from 28 years old in the 1970’s, to 30 in the 1990’s, and now stands at 32.\textsuperscript{1} Since homeowners rarely revert to renting permanent accommodation (shown in Figure 8 below), the decline in home ownership is largely attributable to postponing the first home purchase. Thus starting about 1980 the delay in the transition to homeownership resulted in the stagnation and subsequent reduction of homeownership rates for all cohorts of population in working age (Goodman, Pendall, and Zhu 2015). The delay in first homeownership coincided with postponing marriage and fertility; the average age of mother at first birth rising from 22 forty years ago to 24 two decades ago, and currently stands at about 26. Labor-force participation of females in their fecund period rose dramatically from 48 percent in 1970’s, to 74 percent in 1990’s, hours worked following a similar pattern. Over this 40 year period real wages increased slightly, the real interest rate declined, while housing prices were mainly on the rise. The next section illustrates these empirical patterns and summarizes the data used in this analysis, taken from the Panel Study of Income Dynamics (PSID).

There are many studies showing that household decisions about fertility, labor supply and housing are jointly determined. Increased women’s labor force participation is tightly linked to the delay in giving birth to children, due to the competing allocation of time between work and raising children (Gayle and Miller 2006). Childbearing is strongly associated with the transition to homeownership (Öst 2012). According to Fannie Mae’s National Housing Survey, homeownership as the best environment in which to raise children was among top reasons people buy a home. Therefore delays in fertility stemming from greater female labor force participation might cause women and their partners to postpone homeownership. Causality also seems to run the other way: recent evidence on the effect of homeownership suggests that homeowners are more likely to be employed and may earn more (Munch, Rosholm, and Svarer

\textsuperscript{1} U.S. Bureau of the Census, American Housing Survey, Chicago Title and Trust Co. survey, and authors own calculations based on the Panel Study of Income Dynamics.
2008), and homeowners may have greater fertility rates compared to renters (Dettling and Kearney 2014). We show how our work relates to the existing literature in the latter parts of this introduction.

Whereas the inseparable nature of labor supply, fertility, and homeownership choices is widely acknowledged, to the best of our knowledge, a unifying framework integrating these joint decisions has yet to be analyzed. Our analysis seeks to fill this gap by developing and estimating a dynamic discrete choice model of female labor supply and the timing of births as well as the transition from tenant to homeowner, in order to explain the secular decline in home ownership within the U.S. Section 3 explains our model and empirical strategy, which is based on estimates of the conditional choice probabilities (CCPs) of the household decisions. The parameters of the model capture household fixed costs of transition to homeownership, preferences over home ownership, working (and leisure) choices, the number and timing of children. Technical details on the estimation are relegated to an online Appendix.

The results of the structural estimation are reported in Section 4. All else being equal, households prefer becoming homeowner earlier in life. Therefore the delay in homeownership is not a preference, but rather a result of a trade-off between homeownership and other important life-cycle decisions. The estimated preference parameters suggest that the transition to homeownership is positively related to labor market participation and the presence of children in a household. This finding implies that whereas an increase in labor market participation can speed up the transition to homeownership, having fewer children later in life makes homeownership less attractive. Further, more educated cohorts of females prefer to move into their own home at younger ages, they also get higher utility from giving birth, yet are typically older when having their first child. Finally we fail to uncover any systematic differences in wage rates between homeowners and renters, thereby eliminating one potential channel linking labor supply to home ownership.

Our model can be used to disentangle the effects of fertility decisions and labor supply on housing choices, and to quantify the dynamic feedback that homeownership induces on households’ fertility choices and labor supply. In
Section 5 we solve for counterfactual regimes with the estimated utility function in order to isolate how each exogenous factor in our model contributing to the secular change, the base wage rate, educational attainment, housing price and interest rate quantitatively affected life cycle household decisions regarding labor force participation, births and the transition from tenant to home owner. Very briefly, the estimated model predicts that a higher wage rate (and of course higher housing prices) delay the first home purchase, while and more educated females, and to a lesser extent higher interest rates, bring forwards the transition to home ownership. The last section concludes with a summary of the main empirical results from estimation and the counterfactual exercises.

2 Lifecycle Patterns and Secular Changes

Our analysis is conducted using the PSID for the years 1968 through 1993. This data set has two key advantages for the purpose of this study. First, it contains broad and comprehensive information on household housing, labor supply, income, and detailed family characteristics for a sample of households representative of the US population. To keep the sample representative, from the original data we exclude the poverty subsample and the Latino subsample added closer to the end of our study period. Second, the PSID data set has a panel dimension so that we can measure household transition to homeownership, intertemporal labor supply dynamics and changes in family composition due to births of children.

Demographic characteristics include age, education and marital status of the individual, family size of household, number of children and their ages. Labor force participation data include number of hours put into working activities and the associated income from labor. We collect information on household housing arrangements, including number of rooms in a dwelling, indicator for homeownership, value of primary residence for home owners and amount of rent paid by renters. All monetary values, such as house value for homeowners, rent paid by renters and labor income, are adjusted for inflation using
Consumer Price Index and converted into 1984 dollars. While homeownership choices are made throughout investor’s life, her labor force participation and fertility choices are relevant during investor’s prime age and her fecund period. For this reason, our study considers prime age households of females in their fecund stage of life and excludes observations for individuals younger than 22 or older than 45. We use the same data in constructing motivating figures, conducting basic reduced form analysis, and use it in the estimation of a dynamic structural model.

Table 1 presents summary statistics for the data sample used in the analysis. Over the observed time period, the average homeownership rate for the sample of 22-45 years old females constitutes 64%, which matches the homeownership rate reported for other nationally representative data over the same time period (e.g., U.S. Bureau of the Census, Housing Vacancy Rate Survey, Smith, Rosen, and Fallis 1988).2 The summary statistics for the data sample suggest that there are no substantial differences in education levels between homeowners and renters in the sample of 22-45 years old females. Demographic profile of homeowners differs from the one of renters along the dimensions of age, marital status and the number of children. Homeowners are an older cohort relative to renters, they are more likely to be married and have more children. Figure 2 illustrates homeownership profile over the life cycle, broken down by marital status and the number of children. We display average life cycle homeownership rates for both married and single households with or without children. Homeownership rates are larger for married households than for single ones, reflecting on a strong effect of marriage on the demand for homeownership. Additionally, demand for homeownership is greater for households with children, both married and single. On average, homeownership rate of families with children is 5-7% higher compared to families with the same marital status but without children.

Fisher and Gervais 2011 show that marriage and homeownership are tightly linked, so that the decline in the incidence of marriage during 1980s and fur-

---

2. This rate matches the average homeownership rate in the sample that includes males as well.
ther on results in subsequent reduction of homeownership rates for households aged 25-44 years. The decline in marriage rates was predetermined by women’s liberation movement of the late 1960s and 1970s, with the boost in female educational attainment, increase of workforce participation and delayed motherhood.\textsuperscript{3} These factors changed the dynamics of the relationship between the sexes and resulted in marriage becoming less necessary for women’s economic survival. The decline in marriage is being compensated to some extent by the rise of cohabitation, where almost half of cohabiting households have children, however, it also resulted in the rise of single parent households. The shifts in family composition due to the delay in motherhood (and marriage) translated into the changes in the demand for homeownership. Single homeowners are almost equally split between homeowners with and without children, where both groups of single households reveal a growing trend in homeownership. The share of married homeowners without children is relatively stable over time, while the reduction in married homeownership is largely driven by the declining numbers of married homeowners with children. In the light of the reduced homeownership for the young households, documented in Fisher and Gervais 2011, the decline in married homeowners with children becomes even more dramatic. This evidence calls for a further investigation of the effect of fertility decisions of both married and single households on the demand for homeownership.

The delay in fertility may likely have resulted in the reduced homeownership rates, as illustrated by Figure 4. In early 1970s the average age at having first child was somewhat over 22 years old, while it grows up to 27 in the 1990s. Subsequently, the average age at the birth of second child also became delayed with the average timing between two consecutive birth at 2 years, although there is a reduction of the average time between the first and the second child to 1.5 years by 1990s. Figure 4 also shows that the purchase of the first home has the same trend of being delayed over the life cycle along with the delay in

\textsuperscript{3} Introduction of the birth control pill during those years contributed significantly to gaining control over the timing of fertility, delaying motherhood and enjoying better careers (Miller 2011).
fertility. Timing of children seems to be an important determinant of home-ownership. Figure 4 shows that the age at first homeownership very closely follows the birth of the second child. In early 1970s first homeownership occurs on average one year after the birth of the second child, while in late 1970s and up to early 1990s the timing of the first homeownership and the birth of the second child seem to nearly coincide. Indeed, two thirds of households already have one or more children at the time of purchase of their first home; half of first time home buyers have only 1 or 2 children, and one third have only one child at the time of home purchase. Most of those first children were born one year or two years before the home purchase. Our observations are consistent with the findings in Öst 2012 on the simultaneity of homeownership and childbearing with an important distinction that homeownership decision is likely to be driven by the presence of children in the household, but also is likely to coincide with childbearing beyond the first child.

The delay in fertility provided an opportunity for women to increase their workforce participation, allowed for stronger careers and lead to a better financial standing. Consequently, the delay in home purchase over the life cycle came with an opportunity to purchase a larger home. Figure 5 illustrates that the delayed homeownership trend is aligned with the growing average home size as a number of rooms per family member (the right hand scale) at the time the first home is purchased. The increase in the residential housing size is observed not only for homeowners, but for renters as well, indicating that consumers in general choose larger houses. This evidence from the PSID agrees with the one from the US Census Bureau, according to which the average size of a single-family house in 1970 was 1600 square feet, whereas it was 2400 square feet in 2010. This trend could be the result of the increase in housing affordability, but possibly also due to a greater preference for larger space over time.

Overall, we have illustrated that the decision to buy a home is tightly linked with the fertility decisions and the timing of birth. It also is related to the growing female labor force participation, which opens up an opportunity for a household to buy larger homes. In turn, housing decisions may
have important implications on the fertility and work choices. Dettling and Kearney 2014 show that homeowners respond to growing housing prices with an increase in fertility, which overall can result in greater fertility rates for homeowners in the view of typically growing real estate prices over the period. Greater likelihood of giving birth for homeowners and greater number of children in households-homeowners can be expected to result in the reduced labor force participation and the reduced number of working hours for females-homeowners. Homeowners are more likely to be married and, therefore, enjoy financial support provided by their working spouses. Consequently, they could more likely be expected to drop out of the labor force, or have reduced hours worked. Table 1 shows that there are the differences in both extensive and intensive margins of labor force participation for home owners and renters. Figure 3 shows that labor supply does not differ much for married homeowners and renters, with renters having a somewhat smaller number of hours worked in general. For single females with children, differences in labor supply for homeowners and renters are substantial up to their late 30s and align afterwards. In the absence of substantial differences in labor force participation and hours worked for married households with children, homeowners receive greater hourly wages, as shown in Figure 7. Wage rates for single females with children do not differ much between homeowners and renters, however, they start growing apart after women’s later 30s for single cohort of households. According to Table 1, in general the average difference in labor income between homeowners and renters is substantial, with homeowners earning almost 12% more on average if compared to renters. This finding could be attributed to various factors and calls for further investigation. The difference in earnings could be attributed to a stronger start for homeowners in the beginning of their careers due to the delayed fertility. Alternatively, it could be a result of specific career choices induced by the needs to service greater maintenance costs associated with homeownership. It is also likely that homeownership status signals about stability of the worker. Homeownership may serve as a collateral against unexpected termination of the contract on the worker’s side. Greater expected stability could result in larger responsibilities assigned to
the worker and more rapid carrier achievements. Another possible explanation is the elevated productivity of homeowners. The literature finds support for stronger academic achievements and workplace success of children living in owned homes. If home ownership provides a better environment for children, the same effect could also be valid for adults living in owned homes.

3 The Model

The evidence presented above strongly suggests that households jointly determine their fertility, labor supply and housing decisions over the life cycle. The first parts of this section develop a dynamic model of discrete choice of housing demand, fertility choice and labor supply to explain their decision making process. Then we propose an estimator for characterizing the preferences of the population generating the PSID over the period 1970 through 1990.

3.1 Choices

To focus on the decision of becoming a homeowner we only model accommodation choices for those who have not previously purchased a house and are currently renting. Each period after she purchases her first home, the household makes her current consumption, labor force participation and fertility choices. The birth of a child in period \( t \) is a choice variable denoted by the indicator variable \( b_t \in \{0, 1\} \), where \( b_t = 1 \) if a child is born. Female work-force participation in period \( t \) is given by the indicator variable \( w_t \in \{0, 1\} \), where working is denoted by \( w_t = 1 \). Renting households have a larger choice set, because in addition to choosing \((b_t, w_t)\), they also decide whether to continue renting by setting \( h_t = 0 \) or changing their accommodation status and purchasing their first home, by setting \( h_t = 1 \).

To model the choice set, let \( d_{jt} \in \{0, 1\} \) where \( d_{jt} = 1 \) for:

\[
j \equiv (1 - h_t) b_t (1 - w_t) + 2 (1 - h_t) (1 - b_t) w_t + 3 (1 - h_t) b_t w_t
\]
\[
+ 4 h_t (1 - b_t) (1 - w_t) + 5 h_t b_t (1 - w_t) + 6 h_t (1 - b_t) w_t + 7 h_t b_t w_t
\]
Thus $\sum_{k=0}^{7} d_{jt} = 1$ and the base choice $d_{0t} = 1$ involves setting $(h_t, b_t, w_t) = (0, 0, 0)$. Since purchasing the first house is a once-in-a-lifetime decision, if $h_t = 1$ then $h_{\tau} = 0$ for all $\tau \in \{t + 1, \ldots, T\}$, and hence $\sum_{j=0}^{3} d_{jt} = 1$. In this way the model restricts homeowners to four choices each period $t$, while renters can pick any one of the eight. After period $T$ the household only smooths her accumulated wealth: she retires, has no further children, and continues to rent if she is not already a homeowner, setting $d_{0T} = 1$ for all $t \in \{T + 1, T + 2 \ldots\}$.

### 3.2 Household preferences

The household derives utility from consumption, leisure, offspring, renting or owning a house, and housing services. Preferences are characterized by a discounted sum of a time-additively separable, constant absolute risk-aversion utility function.\(^4\) The utility function is decomposed into utility of consumption of market goods and nonpecuniary factors. The nonpecuniary factors are further decomposed into systematic and nonsystematic components. The systematic component of the nonpecuniary utility is characterized by household-specific indices capturing the influence of household lifetime housing choices and housing characteristics, fertility decisions and family composition, working choices and working history. The nonsystematic component of the flow utility, denoted by $\varepsilon_{jt}$, captures a choice-specific idiosyncratic taste shock for each $j \in \{0, \ldots, 7\}$ and $t \in \{1, \ldots, T\}$. Thus the household’s lifetime utility is modeled as:

\[
- \sum_{s=t}^{\infty} \sum_{j=0}^{7} \beta^{s-t} d_{js} \exp(u_{js}^h + u_{js}^b + u_{js}^f - \rho c_s - \varepsilon_{js})
\]

\(^4\) We adopted the CARA utility function, because we lack reliable information on wealth. During the period of 1968 - 1993, the PSID provides detailed questions on household wealth for only two years, 1984 and 1989, insufficient for modeling of changes in household wealth within a dynamic framework. As explained in Margiotta and Miller 2000, the CARA assumption is useful in this context because it is consistent with consumption smoothing from accumulated wealth and accommodates risk aversion in a parsimonious fashion.
where $\beta$ denotes the subjective discount factor, $\rho$ is the constant absolute risk aversion parameter, $u_{jt}^h \equiv h_t u_t^h$ indexes the utility payoff from buying a house, $u_t^l \equiv w_t u_t^l$ the current utility payoff from leisure time, and $u_t^b \equiv b_t u_t^b$ is the discounted utility stream from births. It immediately follows that if $(h_t, b_t, w_t) = (0, 0, 0)$ then current utility is $\exp(-\rho c_t - \varepsilon_{0t})$. Thus buying the first home, giving birth or working in the labor force raises utility, and as we show in the Appendix the current value function, by a multiplicative scalar.

The indices for housing, leisure and family composition can be further decomposed. We define the home purchase index as:

$$u_t^h \equiv x_t' \theta_0 + x_t' s_t \theta_1 + \theta_{20} s_t^2 + \theta_{21} s_t s_{t-1} + \theta_3 s_t l_t$$

(2)

where $s_t$ measures house size in period $t$, $l_t \in [0, 1]$ is female labor supply in $t$, and $x_t$ is a set of fixed or time varying attributes that characterize the decision maker (including age, education and marital status) along with previous fertility and labor market outcomes. The rationale for including $s_{t-1}$ in the index is that although we do not explicitly model future housing decisions, we do follow resale and future housing purchases. Thus in our model the purchase of the first house is a commitment to continue living in a house owned by the household that matches the changing demographics of the family, rather than in any particular house. Since we cannot assign the value of owning a home to separate periods, we interpret $u_t^h$ as the discounted lifetime increment from becoming a homeowner.

The indices for fertility and labor supply follow the literature. The lifetime utility of giving birth and raising one more child is given by

$$u_t^b \equiv x_t' \gamma_0.$$ 

(3)

where the marginal lifetime utility of a second child is affected by the age of

the first through $x_t$. Finally we define:

$$u_t' \equiv x'_t \delta_0 + \delta_1 x'_t l_t + \delta_{20} l_t^2 + \delta_{21} l_{t-1}$$

(4)

where $x'_t \delta_0$ is the fixed cost of working, and lagged labor supply affects the marginal utility of current leisure, defined as $1 - l_t$.

### 3.3 Budget constraint

In our framework home ownership confers upon the household a right to adapt their living quarters to their own lifestyle in ways that a landlord might object.\(^6\) We model the cost of home ownership as the excess over rents paid to secure those rights; they include but are not limited to the real estate commission paid at the time of sale. In a competitive housing market where some fraction of houses are rented, the price of a house is roughly equal to the discounted sum of its rental stream. Our framework equates rental by tenants for a home of specified characteristics to the implicit rental by homeowners. To simplify the econometric implementation of our model we also assume prices, interest rates and hence aggregate fluctuations are known in advance. Thus fertility and homeownership decisions are not driven by short term financial exigencies in the model but life cycle considerations.

Denote by $e_t$ household financial wealth at the beginning of period $t$, let $c_t$ denote nonhousing consumption, and denote the period $t$ interest rate by $i_t$. Income from real wages paid to the female if she works in period $t$ is denoted by $Y_t$. Rent and implicit rent in period $t$, denoted by $R(s_t, q_t)$, depend on house size $s_t$, plus quality and aggregate factors $q_t$. For future reference we let $s_\tau^{(j,t)}$ and $q_\tau^{(j,t)}$ denote the size and quality of accommodation in period $\tau \in \{t + 1, t + 2, \ldots\}$ subsequent to making discrete choice $j$ at $t$ and always making the base choice afterwards. Thus $R \left( s_\tau^{(j,T)}, q_\tau^{(j,T)} \right)$ denotes rent and implicit rent in periods in period $\tau \in \{T + 1, T + 2, \ldots\}$ after setting $d_{jT} = 1$.

---

\(^6\) In this way we implicitly treat moral hazard issues arising from tenants lack of care for the premises they rent, and other agency issues associated with landlord/tenant relationships.
The price of a house is the discounted sum of implicit rents plus a transaction cost, denoted by $H(s_{t}, q_{t})$, which the household pays to become a homeowner. When becoming a homeowner, the household balances the transaction cost of purchase and a size inertia inherent to homeownership against the benefits of tailoring their own property to individual tastes and having more geographic stability to cultivate social and economic opportunities within the neighborhood.

Define $y_{jt}$ in periods $t$ preceding $T$ as income net of all current accommodation expenses conditional on making choice $j$; define income at period $T$ as net of all current and future accommodation expense obligations. Letting $i_{t}$ denote the one period interest rate in period $t$:

$$y_{jt} \equiv \begin{cases} 
\sum_{j \in \{2,3,6,7\}} d_{jt}Y_{t} - \sum_{j=4}^{7} d_{jt}(\pi + \varphi)H(s_{t}, q_{t}) - R(s_{t}, q_{t}) & t \in \{1, \ldots, T - 1\} \\
\sum_{j \in \{2,3,6,7\}} d_{jT}Y_{T} - \sum_{j=4}^{7} d_{jT}(\pi + \varphi)H(s_{T}, q_{T}) - R(s_{T}, q_{T}) - \sum_{\tau=T+1}^{\infty} \left[ \prod_{r=t+1}^{\tau} \frac{1}{1 + i_{r}} \right] R\left( s_{\tau}^{(j,T)}, q_{\tau}^{(j,T)} \right) & t = T, 
\end{cases}$$

where $\pi$ denotes downpayment rate, and $\varphi$ is the real estate commission rate incurred by household upon completing the home purchase transaction. These definitions imply the law of motion for disposable household wealth is:

$$(1 + i_{t})^{-1} e_{t+1} \leq e_{t} - c_{t} - y_{jt} \quad (5)$$

The left side of the inequality (5) represents household financial resources in $t + 1$ for different contingencies; the right side is the sum of current wealth and labor income less housing and non-housing consumption, plus a one time payment of becoming a homeowner if the householder chooses to buy (for the first time).

### 3.4 State variables

The state variables in the model include (1) those which the household controls directly, namely the composition of the household, labor force experience,
and whether she owns her own home or not, (2) state variables that individually lifestyle but are optimized outside the model (that is conditional on the discrete choices made inside the model), the size and quality of housing accommodation,\(^7\) and (3) aggregate variables, including shifters in housing prices, aggregate wages and interest rates.

The timing and spacing of children affect the benefits they confer upon the household. We track the number and ages of children until they turn 18 years old, when the child becomes a young adult and is assumed to leave the household. We denote by \(a_{it}\) the age of the \(i^{th}\) child in \(t\) for \(i \in \{1, \ldots, I\}\). Let \(n_t\) denote the number of offspring living in the household in period \(t\):

\[
 n_t = n_{t-1} + b_{t-1} - \sum_{i=1}^{I} I\{a_{i,t-1} = 17\}
\]

Thus \(a_t \equiv (a_{1t}, \ldots, a_{It})\) represents both the number and ages of offspring under 18 belonging to the household in period \(t\).

The household also decides whether to work or not, but we do not model how many hours labor force participants work. Age, education, and hours worked in the previous period affect her current wage rate. Denoting female leisure by \(l_t \in [0,1]\), the last remark implies lagged leisure \(l_{t-1}\) is a state variable. House size and quality is not directly determined by the household in our framework, but nevertheless enters as a state variable because of their intertemporal dependence. We assume \((s_t, q_t)\) follows a deterministic process the household knows, and that after purchasing her first home \(s_t = s_{t-1}\). Finally, rather than imposing stationarity in the economy, we allow housing prices, aggregate wages and interest rates to fluctuate over time, but assume future prices can be perfectly forecasted.

### 3.5 Intertemporal choices

At the beginning of each period \(t\) the household observes the vector of disturbances to its preferences, \(\varepsilon_t \equiv (\varepsilon_{0t}, \ldots, \varepsilon_{7t})\), her non-housing assets \(e_t\) and

---

7. See Miller (1997) for more details about including continuous and discrete choices within structural econometric model.
other state variables, denoted by \( z_t \), which include family demographics, housing status, and lagged labor supply \( l_{t-1} \). Family demographics include fixed characteristics, such as educational background, and variables such as age and marital status, along with lagged fertility \( a_t \). The variables on housing status include \( (s_t, q_t) \) and whether the household previously purchased her own home, formally \( h_x = 1 \) for some \( \tau \in \{1, \ldots, t-1\} \). Households are expected utility maximizers, sequentially optimizing the expected value of (1) subject to (5) by choosing \( (b_t, w_t) \), and also \( h_t \) if \( a_{\tau} = 0 \) for all \( \tau \in \{0,1, \ldots, t-1\} \). Let \( p_{jt} (z_t) \) denote the probability of choosing \( j \) at year \( t \) conditional on the value of the household state variable vector \( z_t \) (but not \( e_t \)), and \( B_t \), the current price of a bond in \( t \) that pays one consumption unit each period to eternity.

Denote by \( \varepsilon_{jt}^* \) the truncated variable that takes on the value of \( \varepsilon_{jt} \) when \( d_{jt} = 1 \) and is not defined when \( d_{jt} = 0 \). Adapting Gayle, Golan, and Miller 2015 to our framework, let \( A_{T+1} (z_{T+1}) \equiv 1 \), and recursively define an index of household capital for a household at year \( t \) as:

\[
A_t (z_t) \equiv \sum_{j=0}^{7} p_{jt} (z_t) \exp \left( \frac{u^b_{jt} + u^h_{jt} + \varepsilon_{jt}^* - \rho y_{jt}}{B_t} \right) E_{jt} \left[ \exp \left( \frac{-\varepsilon_{jt}^*}{B_t} \right) \right] A_{t+1} (z_{t+1})^{1 - \frac{1}{\pi_t}}
\]

where \( z_{t+1}^{(j)} \) is the value of the state vector at \( t + 1 \) following the choice \( j \) in period \( t \) applied to \( z_t \), the value of the state vector in the \( t^{th} \) period, \( B_t \) is the current price of a bond paying into perpetuity, \( \varepsilon_{jt}^* \) is the value \( \varepsilon_{jt} \) takes when \( d_{jt} = 1 \), and \( E_{jt} [\cdot] \) is the expectations operator conditioning on \( d_{jt} = 1 \). The index is strictly positive; lower values of \( A_t (z_t) \) come from higher current income and lower rent, both incorporated within \( y_{jt} \), as well as less distasteful \( z_t \) values, associated with higher values of household capital that show up in current and future values of \( u^h_{jt} + u^b_{jt} + u^l_{jt} \). Denote by \( d^o_t = (d^o_1, \ldots, d^o_7) \) the discrete choices that along with the optimal consumption choices, \( c^*_t \), maximize the expected value of (1) subject to (5). The theorem below shows that all the household dynamics are transmitted through \( A_t (z_t) \).
**Theorem 1.** For each \( t \in \{1, 2, \ldots, T\} \) the optimal choices \( d_t \) maximize:

\[
\sum_{j=0}^{7} d_{jt} \left[ \rho y_{jt} - u^b_{jt} - u^l_{jt} - (B_t - 1) \ln A_{t+1}(z^{(j)}_{t+1}) + \varepsilon_{jt} \right]
\]  

(7)

Intuitively, the household maximizes a weighted sum of net current income, the three components of current utility, which in the case of births and new home ownership also impound the future benefits of making a durable choice, plus adjustments to the household capital that potentially affect the magnitude of costs and benefits from future decisions.

### 3.6 Identification and estimation

The model is identified from (7) up to a probability distribution for \( \varepsilon_t \equiv (\varepsilon_{0t}, \ldots, \varepsilon_{7t}) \) and normalizing constants for each state. We assume \( \varepsilon_{jt} \) is independently and identically distributed as a Type I extreme value with location and scale parameters \((0, 1)\). Let \( p_{jt}(z_t) \equiv E_t \left[ d^o_{jt} | z_t \right] \) denote the conditional choice probability (CCP) of optimally making the \( j^{th} \) choice. Noting \( u^h_{0t} = u^b_{0t} = u^l_{0t} = 0 \), it is well known that under this parameterization of the disturbances:

\[
\ln \left[ \frac{p_{0t}(z_t)}{p_{jt}(z_t)} \right] = u^h_{jt} + u^b_{jt} + u^l_{jt} + \rho (y_{0t} - y_{jt}) + (B_t - 1) \ln \left[ \frac{A_{t+1}(z^{(j)}_{t+1})}{A_{t+1}(z^{(0)}_{t+1})} \right]
\]

Let \( z^{(j)}_t \) define the value of the state vector in any period \( \tau \in \{t + 1, \ldots, T\} \) when choice \( j \) made at \( t \) is followed by choice zero for all successive periods. Estimation is based on successively telescoping \( \ln \left[ \frac{A_{t+1}(z^{(j)}_{t+1})}{A_{t+1}(z^{(0)}_{t+1})} \right] \) into the future through to the end of the discrete choice phase at \( T \). The following theorem provides the basis for the CCP estimator used in our application.

---

8. See Hotz and Miller 1993, Magnac and Thesmar 2002 and Arcidiacono and Miller 2016. In fact this model is overidentified because the coefficients on preferences are not separately indexed by calendar time and state.
Theorem 2. For each $j \in \{1, \ldots, 7\}$ and $t \in \{1, \ldots, T\}$:

$$\ln \left[ \frac{p_{jt}(z_t)}{p_{0t}(z_t)} \right] = \rho (y_{jt} - y_{0t}) - u^h_{jt} - u^b_{jt} - u^l_{jt} + \sum_{\tau = t+1}^{T} \prod_{r=t+1}^{\tau} \left( \frac{1}{1 + i_r} \right) \ln \left[ \frac{p_{0\tau}(z^{(0)}_\tau)}{p_{0\tau}(z^{(j)}_\tau)} \right]$$

$$- \sum_{\tau=t+1}^{\infty} \prod_{r=t+1}^{\tau} \left( \frac{1}{1 + i_r} \right) \rho \left[ R \left( s^{(j,t)}_r, q^{(j,t)}_r \right) - R \left( s^{(0,t)}_r, q^{(0,t)}_r \right) \right]$$

This theorem shows that the log odds of the conditional choice probability in period $t$ for buying a house and working but not giving birth (setting $d_{0t} = 1$), versus the base choice of not working, not giving birth and continuing to rent (setting $d_{0t} = 1$), depends on four factors. First is the difference in net income this period $y_{jt} - y_{0t}$ is scaled by the coefficient of absolute risk aversion $\rho$. Recalling that our normalization sets $u^h_{0t} = u^b_{0t} = u^l_{0t} = 0$, the second factor are the differences in utility this period $u^h_{jt} - u^b_{jt} - u^l_{jt}$. Third is the difference in the discounted streams of rental payments from period $t + 1$ onwards, where both streams are generated by making the base choice, but one stream begins with the household owning a home and the other pertains to a household who never becoming a home owner; the terms involving $R \left( s^{(j,t)}_r, q^{(j,t)}_r \right) - R \left( s^{(0,t)}_r, q^{(0,t)}_r \right)$ on the second line of (8) comprise this factor. The remaining terms in (8), a discounted sum of future CCPs, are correction factors to account for the fact that always choosing the base action in future periods is not optimal.\(^9\)

The estimation of the primitives in equation (8) follows a two-step strategy. The first step nonparametrically estimates the CCPs as nuisance parameters using a kernel estimator. The CCP estimates are substituted into equation (8), and the parameters of the utility function are estimated off the empirical counterpart to the resulting moment conditions. Further details about the estimation procedure can be found in the Appendix.

\(^9\) See Proposition 1 of Hotz and Miller 1993.
4 Results

This section describes the structural parameter estimates of household preferences, the estimated wage equation, and measures of fit that compare forecasts of the model with in-sample behavior. To convey some sense of how reasonable our parameter estimates are, we first compare household choices predicted by the model with choices observed in the data. Table 2 illustrates that our model closely tracks in-sample one-period-ahead predictions of the model for family size, labor supply and home ownership at different points in the cycle relative to outcomes observed in the data within the periods of the lifecycle we focus upon. Next we highlight in Table 3, the wage equation estimates for working females, the important role of past experience in building market capital that ultimately helps explain the indirect mechanism that has driven the trend away from home ownership. Table 4 reports the estimated utility function, grouped by the utility components given in Equation (1), which incorporates parameters for the utility from non-housing consumption, housing services (2), raising children (3), and the disutility from working (4). The coefficient estimates are significant and plausible. We show that some simple explanations for the trend away housing purchases receive no support from the data. For example Figure 1 shows female participation rates have increased over the thirty year period under consideration, as has their educational attainment, yet educated women with recent working experience prefer to own a smaller home than postpone ownership and then purchase a larger residence, exactly opposite to the trends Figure 5 displays.

4.1 Model fit

From the PSID sample we obtain relative frequencies on homeownership, labor force participation and family size, conditional on the state variables in the previous year, and compare these cell estimates with the model’s predictions for one period ahead. The details of exercise are provided in Appendix B, and the results of this exercise are reported in Figure 5 and Table 6. This figure and table compares homeownership rate, labor force participation rate,
and total number of children generated by the model to the analogous data characteristics computed from the PSID sample.

The model closely matches homeownership choices from age 25 and on, but over-predict homeownership rate for the very young households between age 21 and 25. It also matches the overall level of labor force participation, somewhat over-predicting working by the very young females, but staying within five percentage points from then on. The model provides a close description of the average number of children born to the households over the life cycle, reaching the peak for average number of children in a household at about age 35, followed by a decline. Specifically, the model predicts child births well in the age range where they are most likely, before age 36. The model slightly overpredicts later births and hence more children than observed in the data; however most families bearing these children already own their own home, so these later births are not germane to our analysis. In summary the model generates choices that track the lifecycle trends in homeownership, labor force participation and family size, closely match the choices observed in the data within those life phases we are most focused on, but is a little frayed at both ends, where the estimated binary probabilities are closer to zero or one, and hence harder to estimate precisely.

4.2 Wage equation

The summary statistics in Table 1 show homeowners and renters differ in their labor force participation, average hours worked, and labor income. Our first set of estimates shed light on why those differences emerge. The estimated wage equation is for the most part standard, including basic demographic characteristics, including age, education, and marital status, along with lagged labor force participation and working hours (see Miller and Sanders 1997; Altug and Miller 1998; Gayle and Miller 2006, for a similar wage equation specification). In view of the last two rows of Table 1, that imply homeowners earn a higher wage rate than tenants, we control for home ownership to investigate the direct effects of ownership status on the wage rate.
Column (2) of Table 3 reports the estimated coefficients on demographic and labor input variables interacted with the homeownership dummy. All the coefficients on variables related to labor supply history interacted with the homeownership dummy are insignificant. Therefore we do not reject the maintained null hypothesis that home ownership does not directly affect the wage rate. If the model is to explain differences in the wage rate between homeowners and renters, they must arise from differences either in their labor supply behavior that feed into the determination of the wage rate, or in the background variables of age, education and marital status.

The results from Table 3 provide mechanisms that might reconcile these differences. Since education interacted with age has a positive effect on wages, part of the positive correlation between home ownership and the wage rate is due to the fact that homeowners are more educated than tenants (shown in the second row in Table 1). Similarly we find marriage magnifies the effect of past hours worked on the current wage rate, a result that resonates with similar conclusions reached by Killewald and Gough 2014 and Eckstein and Keane (Econometrica), and homeowners are more likely to be married. (See Row 3 of Table 1.) Apparently these two factors dominate the negative effect on wages of homeowners working fewer hours than tenants.

### 4.3 Utility parameters

We now investigate how preferences might have caused this trend. Column (1) of Table 4 reports the estimated parameters of the fixed utility of buying a home (along with their estimated standard errors), Column (2) shows the estimates of the utility of home size, while (3) and (4) respectively report the coefficient estimates of the fixed and marginal disutility from working. Before describing the estimates in detail, it is however worth noting two features of the estimates that directly relate to the secular decline with home ownership.

First, as indicated by the Rows 2 and 3 in Table 4, buying a first home and having a child is the strong negative utility from doing both at once, only exacerbated by concurrently working. The intuitive reason is obvious:
undertaking all three activities at once is overwhelming. This might suggest that as fertility rates fell throughout the latter parts of the last century, home ownership should increased, particularly labor force participation speeds up the transition to homeownership, and in addition Past working history is positively associated with the utility of homeownership. Since female labor force attachment increased and fertility declined throughout this period, these estimates would suggest that housing ownership should increase. Yet Figure 1 shows the opposite.

A second standout feature is that the trade off between delayed purchase and larger size evident in the time series in Figure 5 matches with the cross-sectional evidence. Demographic groups that buy earlier tend to own smaller homes, and vice versa. There is only one exception to this rule: the older the youngest child, the less likely a renting household buys a home, and conditional purchase, the smaller the home is likely to be: presumably the household anticipates the older children leaving home soon, and hence opts for a smaller home size. The time trend in Figure 5 is not simply a composition effect of the results displayed in Table 2: a major demographic shift in this sample is the increased formal education of women, yet higher education is associated with earlier home buying. Marriage rates did fall throughout this period, and married households are more likely to live in their own home than single women, but marriage is essentially a contract, with both implicit and explicit dimensions, signifying future resource use, such as labor supply, household housing choices and fertility. We are inclined to interpret declining marriage rates as reflecting a decline in additivities fostered by the marriage contract, rather than a causal factor explaining why those activities have become less prevalent.

The effect of demographic differences on the time of first purchase and its size are statistically significant and intuitively plausible. For example Column (2) shows the estimated utility from house size is increasing and concave. We find that new homeowners choose larger homes relative to the previously rented homes, which is consistent with the statistical facts that rental-occupied housing is typically smaller than owner-occupied housing. Our findings support the
hypothesis that amongst other factors, households value accommodation by the amount of total time spent at home, as roughly measured by the product of the number of household members and the frequency with which they spend time at home. Thus Column 1 shows utility from becoming a home owner is initially increasing (with the addition of a spouse and a first child) but declines in household number thereafter. On this interpretation utility diminishes as the children grow older, aging children having the opposite effect of an aging spouse, because the former grow detached and eventually leave the household.

On another dimension of time spent at home, working women, and those with greater market capital (as measured by labor force participation in the previous period, which increases current wages) tend to prefer smaller homes. Such households are likely to spend less time at home, therefore benefit less during waking hours from housing space, and have less leisure time for housing upkeep, which is greater in bigger houses.

The estimated utility of becoming a home owner is higher for younger and more educated women, but in the case of married women, dampened by having a younger and more educated spouse. All four findings have intuitive interpretations. Younger women are arguably more vulnerable to predation and home ownership confers greater control and security over one’s living arrangements security, while more formal education is correlated with skills that facilitate business transactions in property acquisition. On the flip side, older husbands (typically ineligible for military service) are less effective companions in combatting predation, and those with less formal education have a comparative advantage in home maintenance, a manual occupation that traditionally draws upon physical strength. Finally, utility from homeownership is smaller for non-white households, consistent with the lower homeownership rates for these population segments.

While the choices households make about buying their first home are informative about its value to them, the value derived from their labor supply and fertility choices are affected by their housing status. Column (3) shows the utility of married women from having a(nother) child is enhanced by living in their own home, although this is emphatically not true for single women. More
generally these findings are consistent with empirical evidence that homeownership is beneficial for families with children (Green and White 1997; Haurin, Parcel, and Haurin 2002), and is highly correlated with the fertility decisions (Öst 2012). Home ownership also affects the (mainly nonpecuniary) costs and benefits of labor supply, raising the cost of participation, as reported in Column (4), but for those women supplying labor reducing the burden of working extra hours, Column (5). Thus we find homeowners tend towards a lower labor force participation, but if they work, tend to choose longer working hours (which is consistent with having longer commuting costs, amongst other factors).

To conclude this section we briefly describe our other findings on the utility of giving birth to a child and the disutility of working and work hours, presented in Columns (3) through (5). The utility of giving birth decreases with age and is larger for more educated households: these effects capture the higher fertility rates of more educated older households relative to less educated households, who tend to complete their families at an earlier age. The utility from giving birth is lower for single households, higher if a family already has children, and increasing in the age of their youngest: since young children draw their mothers from the workforce, and human capital from working depreciates with absence, there are investment gains from bunching.

The utility of work also declines with age, is higher for more educated and single households, and lower for non-white households. It is decreasing with children but higher for households with older children. Households are more likely to work if they worked in the previous periods. The utility of supply of working hours is increasing and concave. It is increasing with age, is lower for more educated and single households, and higher for non-white households. The utility from working hours is decreasing with the number of children in a family and with the age of younger child.

5 Counterfactual Decompositions

Comparing trends documented in Section 2 for the driving variables with signs of the estimated coefficients in Section 5 help decipher why home ownership
experienced a secular decline. Several possibilities can be eliminated. Over this period women become more educated, yet highly educated women are more likely to purchase their first home earlier in life than the less schooled. Moreover we find that more educated women exhibit preferences towards a greater number of offspring, which in turn leads feed into demand for earlier home ownership. Similarly the participation rate of women in the workforce increased over this period, yet working women tend to switch from renting to buying when they are younger. Neither factor provides a simple explanation for the decline in home ownership. In our model fertility decreases with higher wages because the opportunity cost of child rearing increases (measured in declining utility). Over this period the reduction in fertility rates, and the associated decline in marriage rates, induced women to rent for longer, overwhelming the other two factors, a higher educated population and greater workforce participation.

Thus higher female wages increased led to workforce participation but also led to a decline in fertility, including postponing marriage and first birth. The former increased the home ownership demand, the latter decreased it. Greater education increased fertility directly and indirectly through increased workforce participation, thus increasing the demand for home ownership. However the effect of declining fertility in postponing home ownership dominated the combined countervailing effects of increased labor supply compounded by rising education levels.

Changes in the wage rate and education achievement were, however, not the only two factors in play. Presumably fluctuating housing prices and interest rates also affected home ownership rates, and perhaps the distribution of the other endogenous outcomes. Although any given factor might be dominant in predicting a particular counterfactual simulations (wages on labor supply for example), it is difficult to cleanly isolate the effect of each, as they are tightly interconnected both contemporaneously and through dynamic feedback on future choices. To disentangle the strength of these factors on the endogenous variables, the last part of our analysis conducts counterfactual simulations, by quantifying the response of homeownership, labor force participation and child
birth to wage increases, greater education, rising interest rates and increasing housing prices. The simulations abstract from the nonstationarities, comparing steady state allocations in an economy populated by households with the estimated utility function where wages, interest rates and prices comparable to those found at different points in the data. Changing one factor at a time, we report the resulting effects on the steady state values to a benchmark economy starting at 1970 levels. First we construct a benchmark simulation based on the conditions observed in 1971, the beginning of our data sample. Then we conduct three other simulations, changing the wage to 1990 value, raising the level of education level from to, housing prices to, and finally interest rate to near its peak value.

From a theoretical perspective housing prices, interest rates and wages are clearly endogenously determined within a general equilibrium framework, jointly determined by considerations we capture in our model as well as the supply rental versus home ownership, the demand for labor, and the supply of credit, which we do not address here. Also as Figure 6 shows, interest rates rose and then fell during this period, while housing prices peaked and slumped three times with an overall upward trend. These fluctuations are a major source of the aggregate nonstationarities that our estimation procedure accounts for. However we cannot solve for and hence simulate the nonstationary economy to quantify these different effects because household decisions made towards the end of the sample are partly determined by aggregate effects that are only revealed after the sample ends. Overcoming these two challenges seems infeasible unless without making strong assumptions. Thus we believe that our approach, although not definitive, gives insight into the quantitative impact of the driving factors.

5.1 Benchmark

The early parts of the data are characterized by the lower levels of education, a lower wage rate for a standardized skill unit which is captured by the time fixed effect, relatively low levels of interest rate and house price index. (See
Figure 6 for the female educational attainment, wage rates, interest rates and house prices in 1970.) Imposing these starting characteristics, we simulate benchmark patterns in homeownership, labor force participation and children using the estimated model parameters. The top panel in Table 5 summarizes home ownership rates, labor force participation and family size for different age groups. Briefly, the average age in the benchmark model at first birth is 21.6 years, is 80 percent of younger women (between 25 and 30 years old) work while the overall labor participation rate for older women (between 30 and 45) is 74 percent, and the average age at becoming a homeowner is 28.7 years. Despite the fact that theses statistics are for a stationary economy, they are remarkably close to the data patterns documented in Figure 1. According the National Vital Statistical System, the average age of mother at first birth in the U.S. grew from 21.4 in 1970s to 24.2 in 1990s (Mathews and Hamilton 2002). While nationally representative records on the average age at first homeownership are scarce, computations based on the PSID show that the average age at first homeownership for 1970-1990 is around 29.10

5.2 Wages

The first policy experiment constitutes an overall and permanent increase in base wages from its level in 1971 to the level reached by 1990. Figure 6 shows that the wage rate almost doubled between 1971 and 1990. Higher wages increase the opportunity cost of leisure and child care, increasing labor force participation by 10 (14) percent for younger (older) women, the average age at first birth by a percentage point to 23.7. The top right panels of Figure 10 show that the differences are most stark at about age 35, where the gap between labor force participation rates is about 20 percent and the difference in family size is about 0.5.

The effect of higher base wages on housing demand operates through multiple channels. Everything else equal, higher labor market compensation and greater wealth increases spending on housing (and other goods) inducing home

ownership at younger ages. However the substitution effect away from domestic activities, including leisure and child rearing reduces the demand for home ownership, a complementary good. This second effect dominates leading to later and less home ownership as the top left panel illustrates, the average age for buying a first home (amongst home owners at age 45) rising from 28.7 to 29.7.

5.3 Education

Figure 6 shows average schooling per female increased by about 1.5 years between the years 1970 and 1990, so our second policy experiment is to compare the benchmark steady state outcomes with those of a steady state in which education is increased by that amount. Table 2 shows that highly educated females exhibit stronger preferences than the less educated towards greater numbers of offspring plus an earlier (and smaller) home purchase. Because they attract higher wage rates (Table 3), they are also more likely to work, providing yet another reason for buying a home, since working females are more likely to live in their own homes than nonworkers. However the greater opportunity cost of domestic time leads to fewer offspring, reducing the demand for homeownership, but not quite offsetting the other channels of influence. Summarizing, labor force participation increases 2 percent for both younger and older women, the average age at first birth to 23.3, while the average at first home purchase falls to 28.2. Similar to the results for base wage increases, the most striking changes from raising the education level by one year are evident (in Figure 10) at around 35 years old when the gap between the labor force participation rates and the number of children peak. However increasing wages from higher educational attainment marginally brings forward the first home purchase, whereas increasing the base wage postpones it.
5.4 House prices

Figure 6 shows house prices were quite volatile between 1970 and 1990, but were generally on a growing trajectory, increasing on average about 15 percent over the two decades. Our next counterfactual experiment investigated how a 15 percent increase in house prices would affect steady state allocations. Not surprisingly, increased prices delay homeownership by -0.2 years on average, Figure 10 showing the gap between homeownership for the benchmark economy versus this one steadily increasing from 0.5 percent for the 21 through 25 age group to 4.3 percent for the 41 through 45 age category. The estimates of the utility parameters in Table 2 indicates that owning a home makes labor force participation less desirable, and increases the benefit of having a child. These results are reflected in Figure 10: with increased housing prices, labor force participation goes up (by between 2 and 7 percent depending on the age group category) and the number of children in a household fall slightly (by 1 to 2 percent).

5.5 Interest rate

Our last counterfactual simulation is concerned with changes in interest rates. The benchmark model is simulated with the conditions of 1991, when interest rates for the observed period were on a lower side. In 1981, interest rates grew up to 14.8%, which, compared to 4.8% rate of 1991, makes a 10 percentage point increase. We take this dramatic increase as a base for this counterfactual expertise. When the interest rate rises households saving for the future experience both a positive wealth effect and a substitution towards market goods consumed in the future. In our model households have completed their education and are saving for retirement. The wealth effect induces them to buy earlier, participate less in the labor force and have larger families, while the substitution effect produces the opposite effects. In our parameterization, the wealth effect dominates, and that a large permanent increase in the interest rate would have quite significant consequences, home ownership rising between 3.4 and 5.9 percent and labor participation falling between 0.7 and
7.5 percent, depending on the age group category. However since interest rates were quite volatile between 1970 and 1990, it is hard to believe they played a very important role, although it is worth noting that over the whole of this period there was a slight net decline, possibly contributing in a marginal way to spurring the decline in home ownership.

6 Conclusion

The delay in first home purchase fully accounts for the decline in home ownership in the U.S. over a 25 year period spanning the 1970s and 1980s. During that time the average age of the first time home buyer and the average age of the mother at first birth increased two years, the buyer’s first home increased in size a little, female labor force participation and labor supply grew substantially and education levels increased. There is widespread agreement that these trends may be interrelated but, to the best of our knowledge, empirical research has not sought to reconcile these three lifecycle choices, fertility, female labor supply and home buying to explain why Americans are making their first home purchase at an older age than the previous generation did.

Over this period interest rates rose and then fell, and the cost of borrowing to buy a house was lower at the end of this period than at the beginning. Moreover first homes bought at the end of the 25 year period were larger than those bought at the beginning of the period even though household size declined average. Indeed there is little to suggest that tighter borrowing constraints and market imperfections caused people to rent longer and buy later. Our model seeks explain these trends within a competitive paradigm based on household responses to market fundamentals and changing demographics, specifically higher wages, their greater education, higher housing prices and a slight decline interest rates; the model is complex not because household preferences are unusual, but because the mix of choices is hard to predict without a unifying framework.

The inherent nonstationarity of the secular trends mentioned in the previous paragraph poses two serious challenges to researchers seeking to under-
stand them and predict the effects of new public policy. First there is the problem of estimating a model of individual (and hence aggregate) behavior seeking to incorporate these interdependent processes; clearly some important decisions individuals in the data set made at the times they are sampled reflect aspects of their life that were relevant after the panel ends, outcomes not observed in the data. To capture these considerations in an internally consistent way, we leverage the close relationship between current (estimated) conditional choice probabilities (CCPs) and future expected utilities impounded within differences between the continuation values (the conditional valuation functions) for alternative choices. In this way the model impounds their expectations about the future within the current equilibrium choices that have long term ramifications. The estimated preference parameters are for the most part statistically significant with intuitively appealing signs and magnitudes. Moreover the one-period ahead forecasts obtained from solving our model with the estimated parameters track both individual lifecycle decisions and aggregate secular changes over this period quite well.

The second challenge in analyzing nonstationary environments is how to make inferences about counterfactuals when the nonstationary process is unknown, almost always the case for a short panel. Even in a model where individuals have perfect foresight, it is impossible to make predictions about future realizations of such a processes without drawing upon information that is outside the data set. Accordingly we follow a common practice in macroeconomics of comparing the long run steady states of different regimes. Our counterfactuals compare wages, housing prices and educational backgrounds roughly corresponding to the beginning and end of the twenty five year sample frame.

Conducting these counterfactuals yielded two new main findings. First is the existence of a transparent transmission mechanism linking the labor market, fertility, and the housing market. Since first home purchase is coordinated with fertility outcomes, the indirect effect of higher wages was to delay home ownership, because higher wages increased the opportunity cost of childcare, lead to postponing first birth and raising smaller families. We find the ef-
fect is comparable to that due to increased housing prices over this period. Second, one might have thought that higher levels of education would also have delayed housing purchases: college graduates start their working careers years after those with high school education or less. We find no support for this conjecture. Controlling for the upward shift in female wages, a stronger schooling background increases labor force participation (and hours) and delays (marriage and) childbirth. Taken together these factors would lead to a delay in the purchase of the household’s first home. However the joint effects are more than offset by a preference for more educated females to own their residence: among 31 though 35 year olds the net effect is quite substantial, about half the size of the effect of increased housing prices and of opposite sign. Two possible explanations come to mind: their work situation might be more secure; perhaps education is useful in negotiating big transactions like housing purchases and loan applications.

Stepping back, this study demonstrates the value of tracing through the effects of changes in the female labor market on the most important durable goods market, housing, in a nonstationary environment where the pronounced secular trends over the period we studied provide an exogenous source of variation to exploit in estimation.

References


Appendices

A Appendix

Proof of Theorem 1. Define the date zero price of a bond that pays a consumption unit each period from date $t$ onwards as:

$$
\tilde{B}_t \equiv \sum_{s=t}^{\infty} \left( \frac{1}{1 + i^{(s)}} \right) = \tilde{B}_{t+1} + \frac{1}{1 + i^{(t)}}
$$

where $i^{(t)} \equiv \prod_{s=0}^{t} (1 + i_s) - 1$ is the compound interest rate over the first $t$ periods. Let:

$$
\tilde{Q}_t \equiv \sum_{s=t}^{\infty} \frac{\ln \left[ \beta^s \left( 1 + i^{(s)} \right) \right]}{(1 + i^{(s)})} = \tilde{Q}_{t+1} + \frac{\ln \left[ \beta^t \left( 1 + i^{(t)} \right) \right]}{(1 + i^{(t)})}
$$

For convenience we also define:

$$
\alpha_{jt} \equiv \exp \left( u^b_{jt} + u^b_{jt} + u^l_{jt} \right)
$$

and note that $\alpha_{0t} = 1$ for all $t$.

After making all its discrete choices before period $T$, the household chooses its remaining lifetime consumption profile $\{c_t\}_{t=T+1}^{\infty}$ to maximize:

$$
- \sum_{t=T+1}^{\infty} \beta^t \exp (-\rho c_t)
$$

subject to a sequence of budget constraints:

$$(1 + i_t)^{-1} e_{t+1} \leq e_t - c_t$$
The indirect utility function for this Lagrangian problem is:

\[
V_{T+1}(e_{T+1}) = -\tilde{B}_{T+1} \exp \left( \frac{\tilde{Q}_{T+1}}{\tilde{B}_{T+1}} - \frac{\rho e_{T+1}}{(1 + i(T+1)) \tilde{B}_{T+1}} \right)
\]

Suppose a household with state variables \(z_T\) makes choice \(j\) at age \(T\) for one period and then retires. Let \(y_{jT}\) denote net income for the last period in which the household makes discrete choices; it includes wage income for the last period and the discounted sum of all future rents:

\[
y_{jT} = (1 - l_{jT}) w_T - \left[ 1 + i^{(T)} \right] \sum_{t=T+1}^{\infty} R(s^{(j)}_t, q^{(j)}_t) (1 + i^{(t)})
\]

Note that future rents payable depend on the final housing choice. After selecting choice \(j\), and receiving income \(y_{jT}\), she chooses consumption and next period’s endowment \((c_T, e_{T+1})\) optimally to maximize:

\[
-\beta^T \alpha_{jT} \exp (-\varepsilon_{jT}) \exp (-\rho c_T) - \bar{B}_{T+1} \exp \left( \frac{\tilde{Q}_{T+1}}{\bar{B}_{T+1}} - \frac{\rho e_{T+1}}{(1 + i(T+1)) \bar{B}_{T+1}} \right)
\]

subject of her budget constraint:

\[
\frac{e_T}{1 + i^{(T)}} + \frac{y_{jT}}{1 + i^{(T)}} = \frac{e_{T+1}}{1 + i^{(T+1)}} + \frac{c_T}{1 + i^{(T)}}
\]

Denoting by \(V_{jT}(e_T)\) the discounted sum of expected utility for a householder of age \(T\) onwards with wealth \(e_T\) who chooses \(j\) and makes optimal consumption choices thereafter, we can apply Lagrangian methods to show:

\[
V_{jT}(e_T) = -\tilde{B}_T \alpha_{jT}^{1/\tilde{B}_T(1+i^{(T)})} \exp \left\{ \frac{\tilde{Q}_T}{\tilde{B}_T} - \frac{\varepsilon_{jT}}{\tilde{B}_T [1 + i^{(T)}]} - \frac{\rho (e_T + y_{jT})}{\tilde{B}_T [1 + i^{(T)}]} \right\}
\]

\[
= -\tilde{B}_T \alpha_{jT}^{1/\tilde{B}_T(1+i^{(T)})} \exp \left[ \frac{Q_T}{\bar{B}_T} - \frac{\varepsilon_{jT}}{\bar{B}_T} - \frac{\rho (e_T + y_{jT})}{\bar{B}_T} \right]
\]

where the second line exploits the relationships \(B_T = \tilde{B}_T (1 + i^{(T)})\) and \(Q_T = \tilde{Q}_T (1 + i^{(T)})\).

Appealing to the definition of \(A_t(z_t)\) given in the text, we can now prove by an induction argument that, conditional on choosing \(j\), the value function
at \(t\) discounted back to date zero is:

\[
V_{jt} (e_t, z_t, \varepsilon_{jt}) = \frac{-B_t}{(1 + i(t))^{\alpha_{jt}}} \exp \left[ \frac{Q_t}{B_t} - \frac{\varepsilon_{jt}}{B_t} - \frac{\rho \left( e_t + y_{jt} \right)}{B_t} \right] A_{t+1} \left( \frac{\varepsilon_{t+1}}{\alpha_{t+1}} \right)^{\frac{1}{\alpha_{t+1}}}
\]

At time \(t\) the household chooses \(j\) to maximize \(V_{jt} (e_t, z_t, \varepsilon_{jt})\). Since maximizing an objective function is equivalent to minimizing the logarithm of its negative, the maximum can be found by minimizing:

\[
\ln \frac{B_t}{(1 + i(t))^{\alpha_{jt}}} + \ln \frac{Q_t}{B_t} - \rho \frac{e_t + y_{jt}}{B_t} - \frac{\varepsilon_{jt}}{B_t} + \left( 1 - \frac{1}{B_t} \right) \ln A_{t+1} \left( \frac{\varepsilon_{t+1}}{\alpha_{t+1}} \right)
\]

The proof is completed by multiplying the expression above by \(B_t\), subtracting terms that do not depend on \(j\), appealing to (9) and rearranging.

*Proof of Theorem 2.* It is helpful to define the date zero price of a bond which pays a consumption unit each from date \(t\) onwards as:

\[
\tilde{B}_t \equiv \sum_{s=t}^{\infty} \left( \frac{1}{1 + i(s)} \right) = \tilde{B}_{t+1} + 1 \frac{1}{1 + i(t)}
\]

(14)

where \(i(t) \equiv \prod_{s=0}^{t} (1 + i_s) - 1\) is the compound interest rate over the first \(t\) periods, and that:

\[
\frac{\tilde{B}_{t+1}}{\tilde{B}_t} = 1 - \frac{1}{\tilde{B}_t [1 + i(t)]} = 1 - \frac{1}{B_t}
\]

(15)

It is well known and note that if \(\varepsilon_{jt}\) is independently and identically distributed as a Type I extreme value with location and scale parameters \((0, 1)\) then from Theorem 1:

\[
\ln \left[ \frac{p_{0t} (z_t)}{p_{jt} (z_t)} \right] = \rho y_{0t} - (B_t - 1) \ln A_{t+1} \left( \frac{\varepsilon_{t+1}}{\alpha_{t+1}} \right) - \left[ \rho y_{jt} - \ln (\alpha_{jt}) - (B_t - 1) \ln A_{t+1} \left( \frac{\varepsilon_{t+1}}{\alpha_{t+1}} \right) \right]
\]

\[
= \rho (y_{0t} - y_{jt}) + \ln (\alpha_{jt}) + (B_t - 1) \ln \left[ \frac{A_{t+1} \left( \frac{\varepsilon_{t+1}}{\alpha_{t+1}} \right)}{A_{t+1} \left( \frac{\varepsilon_{0}}{\alpha_{0}} \right)} \right]
\]
Exponentiating the result and raising to the power $1/B_t$, we obtain:

$$
\left[ \frac{p_{0t}(z_t)}{p_{jt}(z_t)} \right]^\frac{1}{B_t} \exp \left[ -\frac{\rho(y_{jt} - y_{0t})}{B_t} \right] \left[ \frac{A_{t+1}(z_{t+1})}{A_{t+1}(z_{0t})} \right]^{1-\frac{1}{B_t}} \tag{16}
$$

Rearranging equation (16) we obtain:

$$
\alpha_{jt}^\frac{1}{B_t} \exp \left( -\frac{\rho y_{jt}}{B_t} \right) A_{t+1}(z_{t+1})^{1-\frac{1}{B_t}} = \left[ \frac{p_{0t}(z_t)}{p_{jt}(z_t)} \right]^{\frac{1}{B_t}} A_{t+1}(z_{t+1})^{1-\frac{1}{B_t}} \exp \left( -\frac{\rho y_{0t}}{B_t} \right) \tag{17}
$$

From the definition of $A_t(z_t)$:

$$
A_t(z_t) = \sum_{j=0}^{J} p_{jt}(z_t) \alpha_{jt}^\frac{1}{B_t} E \left[ \exp \left( -\frac{\varepsilon_{jt}}{B_t} \right) \right] \exp \left( -\frac{\rho y_{jt}}{B_t} \right) A_{t+1}(z_{t+1})^{1-\frac{1}{B_t}} \tag{17}
$$

Substituting the left hand side into the recursion for $A_t$ given in Equation (17) yields:

$$
A_t(z_t) = \sum_{j=0}^{J} p_{jt}(z_t) E \left[ \exp \left( -\frac{\varepsilon_{jt}}{B_t} \right) \right] \exp \left( -\frac{\rho y_{0t}}{B_t} \right) \left[ \frac{p_{0t}(z_t)}{p_{jt}(z_t)} \right]^{\frac{1}{B_t}} A_{t+1}(z_{t+1})^{1-\frac{1}{B_t}}
$$

But from the online appendix of Gayle, Golan, and Miller 2015:

$$
E \left[ \exp \left( -\frac{\varepsilon_{jt}}{B_t} \right) \right] = p_{jt}(z_t)^{\frac{1}{B_t}} \Gamma \left( \frac{B_t + 1}{B_t} \right)
$$

where $\Gamma(\cdot)$ is the complete gamma function. Substituting for the left hand in the expression derived for $A_t(z_t)$ above it thus yields:

$$
A_t(z_t) = p_{0t}(z_t)^{\frac{1}{B_t}} \Gamma \left( \frac{B_t + 1}{B_t} \right) \sum_{j=0}^{J} p_{jt}(z_t) \exp \left( -\frac{\rho y_{jt}}{B_t} \right) A_{t+1}(z_{t+1})^{1-\frac{1}{B_t}}
$$

$$
= \Gamma \left( \frac{B_t + 1}{B_t} \right) p_{0t}(z_t)^{\frac{1}{B_t}} \exp \left( -\frac{\rho y_{0t}}{B_t} \right) A_{t+1}(z_{t+1})^{1-\frac{1}{B_t}}
$$

or:

$$
\ln A_t(z_t) = \ln \left( \frac{B_t + 1}{B_t} \right) + \frac{1}{B_t} \ln p_{0t}(z_t) - \frac{\rho y_{0t}}{B_t} + \left( 1 - \frac{1}{B_t} \right) \ln A_{t+1}(z_{t+1})^{(0)}
$$

37
Using this expression to difference \( \log A_{t+1}(z_{t+1}) \) with \( \log A_{t+1}(z_{t+1}) \) gives:

\[
\ln \left[ \frac{A_{t+1}(z_{t+1})}{A_{t+1}(z_{t+1})} \right] = \frac{1}{B_{t+1}} \left\{ \ln \left[ \frac{p_{0,t+1}(z_{t+1})}{p_{0,t+1}(z_{t+1})} \right] - \rho(y_{t+1} - y_{t+1}) \right\} + \left( 1 - \frac{1}{B_{t+1}} \right) \ln \left[ \frac{A_{t+1}(z_{t+1})}{A_{t+1}(z_{t+1})} \right]
\]

where the second line follows from (15). Telescoping to period \( T \) and appealing to the fact that \( A_{T+1} \left( z_{T+1} \right) = 1 \) yields:

\[
\ln \left[ \frac{A_{t+1}(z_{t+1})}{A_{t+1}(z_{t+1})} \right] = \frac{1}{B_{t+1}} \sum_{s=t+1}^{T} \frac{1}{1 + i(s)} \left\{ \ln \left[ \frac{p_{0,s}(z_{s})}{p_{0,s}(z_{s})} \right] - \rho \left( y_{s}^{(j,i)} - y_{s}^{(i,j)} \right) \right\}
\]

Taking the logarithm of (16), multiplying by \( -B_{t} \) and substituting the expression for \( A_{t+1}(z_{t+1}) \), obtained in (18), yields:

\[
\ln \left[ \frac{p_{jt}(z_{t})}{p_{0t}(z_{t})} \right] = \rho(y_{jt} - y_{0t}) - \ln(\alpha_{jt}) + (1 - B_{t}) \ln \left[ \frac{A_{t+1}(z_{t+1})}{A_{t+1}(z_{t+1})} \right]
\]

But from (15):

\[
\tilde{B}_{t+1} = \tilde{B}_{t} - \frac{\tilde{B}_{t}}{B_{t}} = \frac{B_{t} (B_{t} - 1)}{B_{t}}
\]

implying:

\[
\frac{1 - B_{t}}{B_{t+1}} = \frac{(1 - B_{t}) B_{t}}{B_{t} (B_{t} - 1)} = \frac{B_{t}}{B_{t}} = - [1 + i(t)]
\]
Therefore:

\[
\ln \left[ \frac{p_{jt}(z_t)}{p_{0t}(z_t)} \right] = \rho (y_{jt} - y_{0t}) - \ln (\alpha_{jt}) - \sum_{s=t+1}^{T} \frac{1 + i^{(t)}}{1 + i^{(s)}} \left\{ \ln \left[ \frac{p_{0s}\left(z_s^{(j)}\right)}{p_{0s}\left(z_s^{(0)}\right)} \right] - \rho \left( y_s^{(j,t)} - y_s^{(0,t)} \right) \right\}
\]

\[
= \rho (y_{jt} - y_{0t}) - \ln (\alpha_{jt}) + \sum_{s=t+1}^{T} \prod_{r=t+1}^{s} \frac{1}{1 + i_r} \left\{ \rho (y_s^{(j,t)} - y_s^{(0,t)}) + \ln \left[ \frac{p_{0s}\left(z_s^{(0)}\right)}{p_{0s}\left(z_s^{(j)}\right)} \right] \right\}
\]

Appealing to (9) and definition of \( y_s^{(j,t)} \) the theorem is proved. \( \square \)

### B Simulation details

Let \( t \) denote the age of a female. Let \( z_t \) denote state vector, such that \( z_t = (z_t^f, z_t^v) \). Components of \( z^f \) include state variables fixed for a given female. These characteristics include education, race, marital status and bond price regime. Education is divided into 4 categories, which correspond to “less than high school”, “high school”, “some college”, and “college degree”. Race includes two categories: white and non-white. Marital status includes married and single households. Bond price regime for the benchmark simulation correspond to the average interest rate of 8% over the period 1972 - 1993. Variable components of state vector, \( z^v \) include householder’s age, number of children in household at time \( t - 1 \), age of the youngest child at time \( t - 1 \), leisure choice at \( t - 1 \), home size at \( t - 1 \) and home-ownership status at \( t - 1 \).

A female decides on giving birth to a child or not, on new allocation of hours to leisure, and, if a renter, whether to become a homeowner or not. The decision to work is then determined by a non-unity leisure choice. We discretize possible continuous outcomes of leisure time, and housing characteristics on a fine grid, which increases the number of choices beyond eight choices considered in the model estimation up to \( J \), where \( J \) depends on the fineness of the grid.

The participation ratios \( p_{j,t} \), \( j = 0,...,J-1 \) are computed by solving the model backwards, starting from the termination condition. Termination condition is set to occur at age 65 after which a household terminates. A household may enjoy a payoff \( v_{j,65} \), however no future decisions are possible, which results in the ratio of conditional choice probabilities being set to one: \( p_{0,65}(z_{j,64}^{(1)})/p_{0,65}(z_{0,64}^{(1)}) = 1 \), so that we have:

\[
\ln \frac{p_{j,64}}{p_{0,64}} = - \ln \alpha_{j,64} - (b_r - 1) (\ln E_{64}(v_{j,65})) . \tag{19}
\]
Equation (19) allows us to evaluate $p_{j64}$, $j = 0, ...J - 1$, which are then being fed into an equation for age 63:

$$\ln \frac{p_{j,63}}{p_{063}} = - \ln \alpha_{j,63} - (b_r - 1) \left( \ln E_{63}(v_{j,64}) + \frac{1}{b_{r+1}} \ln \frac{p_{0,64}(z_{j,63})}{p_{0,64}(z_{0,63})} \right).$$

The procedure is continued recursively until the age 22:

$$\ln \frac{p_{j,22}}{p_{022}} = - \ln \alpha_{j,22} - (b_r - 1) \left( \ln E_{22}(v_{j,23}) + \sum_{s=1}^{17} \frac{1}{b_{r+s}} \prod_{r=1}^{s-1} \left[ 1 - \frac{1}{b_{r+r}} \right] \ln \frac{p_{0,22+s}(z_{j,22})}{p_{0,22+s}(z_{0,22})} \right).$$

From equation (20) one can notice that the planning horizon cannot exceed 17 years. This horizon length is the longest from possible planning horizons. The planning horizons for three decisions, which we consider in this paper, do not have to coincide. For decision to work, we can rely on finite dependence (shown in Altug and Miller 1998, and further formalized in Arcidiacono and Miller 2011), which occurs in two periods in our model specification. The decision to buy a house may involve a planning horizon based on household expectations about the length of the tenure in a chosen home. According to the 2009 American Community Survey, the median length of tenure in the same house for homeowners is 10 years. Finally, if a female gives birth to a child, she expects to care for this child until the child turns 18, when, according to our assumption, the child leaves the parent family and forms her own household. Once the youngest child reaches age of 18 and leaves a household, no more children are born to the household as the probability of such cases is very small.
Figure 1: Labor force participation rate by age for 1970 - 2000. “Star” denotes median age at first marriage, “circle” denotes average age at first birth, “triangle” denotes average age at first homeownership. Age at first marriage is taken from the U.S. Census Bureau, age at first birth is taken from the National Vital Statistical Reports (Mathews and Hamilton, 2002), age at first homeownership is computed from the PSID, whereas labor force participation rates are taken from publications of the U.S. Bureau of Labor Statistics (Toossi 2002, 2012).
Figure 2: Average homeownership rate.

Figure 3: Average hours worked for females with children.

Figure 4: Timing of children and first homeownership.

Figure 5: First homeownership and average home size.
### Table 1: Summary statistics

<table>
<thead>
<tr>
<th></th>
<th>Full sample</th>
<th>Owners</th>
<th>Renters</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td>32.4 (6.6)</td>
<td>33.9 (6.3)</td>
<td>29.7 (6.1)</td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td>13.0 (2.2)</td>
<td>13.0 (2.1)</td>
<td>12.9 (2.3)</td>
</tr>
<tr>
<td><strong>Married</strong></td>
<td>0.82 (0.38)</td>
<td>0.92 (0.26)</td>
<td>0.64 (0.48)</td>
</tr>
<tr>
<td><strong>White</strong></td>
<td>0.89 (0.31)</td>
<td>0.93 (0.26)</td>
<td>0.82 (0.38)</td>
</tr>
<tr>
<td><strong>Number of children</strong></td>
<td>1.53 (1.30)</td>
<td>1.67 (1.24)</td>
<td>1.28 (1.36)</td>
</tr>
<tr>
<td><strong>Home ownership rate</strong></td>
<td>0.64 (0.47)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>House value for home owners</strong></td>
<td>66,381 (42,859)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Annual rent for renters</strong></td>
<td></td>
<td>2,956 (2,102)</td>
<td></td>
</tr>
<tr>
<td><strong>Move to owned house</strong></td>
<td>0.087 (0.282)</td>
<td>0.062 (0.241)</td>
<td>0.064 (0.244)</td>
</tr>
<tr>
<td>own-to-own**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>rent-to-own***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Move to rental house</strong></td>
<td>0.126 (0.331)</td>
<td>0.329 (0.470)</td>
<td>0.041 (0.198)</td>
</tr>
<tr>
<td>rent-to-rent***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>own-to-rent***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Number of rooms in dwelling</strong></td>
<td>5.8 (1.7)</td>
<td>6.4 (1.5)</td>
<td>4.7 (1.5)</td>
</tr>
<tr>
<td><strong>Labor force participation</strong></td>
<td>0.753 (0.430)</td>
<td>0.736 (0.440)</td>
<td>0.783 (0.411)</td>
</tr>
<tr>
<td><strong>Hours worked</strong>*</td>
<td>1,497 (742)</td>
<td>1,479 (741)</td>
<td>1,527 (743)</td>
</tr>
<tr>
<td><strong>Labor income</strong>*</td>
<td>11,070 (8,850)</td>
<td>11,504 (9,374)</td>
<td>10,341 (7,842)</td>
</tr>
<tr>
<td><strong>Number of observations</strong></td>
<td>43,504</td>
<td>27,871</td>
<td>15,633</td>
</tr>
</tbody>
</table>

Sample averages for females between 22 and 45 years old, standard deviations are in parenthesis; data covers 1968 through 1993.

*Conditional on working.

**Including observations on households who spend one or two years of renting between two consecutive home ownerships.

***Excluding observations on households who spend one or two years of renting between two consecutive home ownerships.
Table 2: Period-Specific Utility

\[ u_t^h = d_t^h (x_t^h \theta_0 + x_t^h s_t \theta_1 + \theta_2 s_t^2 + \theta_3 s_t s_{t-1} + \theta_4 s_{t-1}^2) \]
\[ u_t^w = d_t^w x_t^w \delta_0 + \delta_1 x_t^w l_t + \delta_2 l_t^2 + \delta_3 l_t l_{t-1} \]
\[ u_t^k = d_t^k x_t^k \gamma_0 \]

<table>
<thead>
<tr>
<th>Utility from:</th>
<th>Home Purchase</th>
<th>Home size</th>
<th>Offspring</th>
<th>Work</th>
<th>Work hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
</tr>
<tr>
<td>(d_t^h \times)</td>
<td>1.103 (0.468)</td>
<td>0.617 (0.082)</td>
<td>2.121 (0.194)</td>
<td>0.002 (0.168)</td>
<td>5.750 (0.914)</td>
</tr>
<tr>
<td>(s_t \times)</td>
<td>-3.249 (0.490)</td>
<td>97.429 (0.583)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work*Birth</td>
<td>-22.771 (0.515)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Demographic characteristics \((x_t)\)

<table>
<thead>
<tr>
<th></th>
<th>Home Purchase</th>
<th>Home size</th>
<th>Offspring</th>
<th>Work</th>
<th>Work hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female age</td>
<td>-0.202 (0.014)</td>
<td>0.039 (0.002)</td>
<td>-0.415 (0.005)</td>
<td>-0.034 (0.005)</td>
<td>0.074 (0.024)</td>
</tr>
<tr>
<td>Female education</td>
<td>0.435 (0.029)</td>
<td>-0.066 (0.005)</td>
<td>0.143 (0.011)</td>
<td>0.127 (0.009)</td>
<td>-0.447 (0.050)</td>
</tr>
<tr>
<td>Husbands age</td>
<td>0.089 (0.012)</td>
<td>-0.013 (0.002)</td>
<td>-0.020 (0.005)</td>
<td>-0.013 (0.004)</td>
<td>0.069 (0.022)</td>
</tr>
<tr>
<td>Husbands education</td>
<td>-0.510 (0.026)</td>
<td>0.081 (0.004)</td>
<td>0.136 (0.010)</td>
<td>-0.075 (0.008)</td>
<td>0.264 (0.044)</td>
</tr>
<tr>
<td>Single</td>
<td>-10.258 (0.543)</td>
<td>0.412 (0.090)</td>
<td>-5.777 (0.215)</td>
<td>1.661 (0.201)</td>
<td>-11.161 (1.024)</td>
</tr>
<tr>
<td>Non-White</td>
<td>-8.942 (0.203)</td>
<td>0.482 (0.035)</td>
<td>-0.567 (0.080)</td>
<td>-1.331 (0.074)</td>
<td>9.515 (0.397)</td>
</tr>
<tr>
<td>Single*Non-White</td>
<td>-23.633 (0.564)</td>
<td>2.377 (0.091)</td>
<td>5.269 (0.165)</td>
<td>-1.132 (0.154)</td>
<td>13.606 (0.764)</td>
</tr>
<tr>
<td>Children at (t-1)</td>
<td>3.673 (0.135)</td>
<td>-0.149 (0.021)</td>
<td>4.291 (0.050)</td>
<td>-0.726 (0.042)</td>
<td>-2.987 (0.241)</td>
</tr>
<tr>
<td>Children sq. at (t-1)</td>
<td>-2.843 (0.043)</td>
<td>0.135 (0.007)</td>
<td>-2.465 (0.015)</td>
<td>0.076 (0.010)</td>
<td>-0.423 (0.063)</td>
</tr>
<tr>
<td>Age of last child</td>
<td>-0.341 (0.020)</td>
<td>-0.058 (0.003)</td>
<td>-1.482 (0.006)</td>
<td>0.121 (0.006)</td>
<td>-0.394 (0.030)</td>
</tr>
<tr>
<td>Homeowner at (t-1)</td>
<td>2.647 (0.055)</td>
<td>-0.652 (0.041)</td>
<td>5.109 (0.213)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single*Homeowner at (t-1)</td>
<td>-16.365 (0.148)</td>
<td>-1.001 (0.165)</td>
<td>8.326 (0.735)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current home size ((s_t))</td>
<td>-0.046 (0.004)</td>
<td>0.014 (0.012)</td>
<td>-0.003 (0.006)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prior home size ((s_{t-1}))</td>
<td>0.010 (0.001)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employed at (t-1) ((d_{t-1}^w))</td>
<td>0.189 (0.035)</td>
<td>1.434 (0.028)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work time ((l_t))</td>
<td>-2.113 (0.025)</td>
<td>-130.931 (0.853)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work time at (t-1) ((l_{t-1}))</td>
<td>-0.301 (0.029)</td>
<td>97.429 (0.583)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NOTE: J-test= 235.241, with 85.000 degrees of freedom and probability value of 0.000
Table 3: Wage equation

\[ \ln(wage_{it}) = B_1 X_{it} + B_2(O_{it}X_{it}) + \mu_t + \eta_i + \epsilon_{it}, \]
where \( O_{it} \) is a dummy for homeowner

<table>
<thead>
<tr>
<th>( X_t )</th>
<th>( B_1 )</th>
<th>( B_2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \Delta ) Hours worked at ( t - 1 )</td>
<td>0.113 (0.006)</td>
<td>0.007 (0.005)</td>
</tr>
<tr>
<td>( \Delta ) Work at ( t - 1 )</td>
<td>-0.049 (0.009)</td>
<td>0.014 (0.011)</td>
</tr>
<tr>
<td>( \Delta ) (Age\times\text{Education})</td>
<td>0.639 (0.119)</td>
<td>0.048 (0.059)</td>
</tr>
<tr>
<td>( \Delta ) Age(^2)</td>
<td>-0.241 (0.044)</td>
<td>-0.031 (0.022)</td>
</tr>
<tr>
<td>( \Delta ) Marital*Hours worked at ( t - 1 )</td>
<td>0.039 (0.007)</td>
<td></td>
</tr>
</tbody>
</table>
Figure 6: Educational attainment for female population 15 years old and over measured as the average years of total schooling, constructed based on data from Barro and Lee (2013). Women’s earnings as a percentage of men’s earnings. Wage rate is computed by the authors based on the PSID data sample. One-year Treasury constant maturity rate (GS1) is retrieved from FRED, Federal Reserve Bank of St. Louis, whereas U.S. National Home Price Index is based on Shiller (2015).
Figure 7: Average hourly wages conditional on working for females with children.

Figure 8: Transition from homeownership to renting
Figure 9: One-period in-sample model prediction versus observed data.

Table 4: Simulation results: one-period in-sample model prediction versus observed data

<table>
<thead>
<tr>
<th>Age</th>
<th>21-25</th>
<th>26-30</th>
<th>31-35</th>
<th>36-40</th>
<th>41-45</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homeownership rate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data</td>
<td>0.37</td>
<td>0.57</td>
<td>0.72</td>
<td>0.77</td>
<td>0.81</td>
</tr>
<tr>
<td>Model</td>
<td>0.48</td>
<td>0.60</td>
<td>0.72</td>
<td>0.79</td>
<td>0.83</td>
</tr>
<tr>
<td>Labor force participation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data</td>
<td>0.79</td>
<td>0.75</td>
<td>0.75</td>
<td>0.77</td>
<td>0.75</td>
</tr>
<tr>
<td>Model</td>
<td>0.87</td>
<td>0.80</td>
<td>0.74</td>
<td>0.72</td>
<td>0.73</td>
</tr>
<tr>
<td>Children</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data</td>
<td>0.86</td>
<td>1.34</td>
<td>1.85</td>
<td>1.92</td>
<td>1.43</td>
</tr>
<tr>
<td>Model</td>
<td>0.92</td>
<td>1.35</td>
<td>1.87</td>
<td>1.99</td>
<td>1.60</td>
</tr>
</tbody>
</table>
Figure 10: Counterfactual simulations.
Table 5: Counterfactual simulation results

<table>
<thead>
<tr>
<th></th>
<th>21-25</th>
<th>26-30</th>
<th>31-35</th>
<th>36-40</th>
<th>41-45</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Benchmark</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Homeownership rate</td>
<td>0.43</td>
<td>0.59</td>
<td>0.68</td>
<td>0.75</td>
<td>0.79</td>
</tr>
<tr>
<td>Labor force participation</td>
<td>0.86</td>
<td>0.74</td>
<td>0.68</td>
<td>0.70</td>
<td>0.87</td>
</tr>
<tr>
<td>Children</td>
<td>1.09</td>
<td>1.49</td>
<td>1.72</td>
<td>1.25</td>
<td>0.63</td>
</tr>
<tr>
<td><strong>A. Wage as in 1990</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Homeownership rate</td>
<td>0.40</td>
<td>0.54</td>
<td>0.63</td>
<td>0.71</td>
<td>0.76</td>
</tr>
<tr>
<td>Difference</td>
<td>-3.2%</td>
<td>-5.3%</td>
<td>-4.7%</td>
<td>-4.0%</td>
<td>-3.3%</td>
</tr>
<tr>
<td>Labor force participation</td>
<td>0.93</td>
<td>0.88</td>
<td>0.85</td>
<td>0.86</td>
<td>0.96</td>
</tr>
<tr>
<td>Difference</td>
<td>6.3%</td>
<td>14.0%</td>
<td>16.7%</td>
<td>16.2%</td>
<td>8.6%</td>
</tr>
<tr>
<td>Children</td>
<td>0.94</td>
<td>1.17</td>
<td>1.33</td>
<td>0.94</td>
<td>0.51</td>
</tr>
<tr>
<td>Difference</td>
<td>-14%</td>
<td>-22%</td>
<td>-23%</td>
<td>-25%</td>
<td>-19%</td>
</tr>
<tr>
<td><strong>B. Education level as in 1990</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Homeownership rate</td>
<td>0.43</td>
<td>0.61</td>
<td>0.69</td>
<td>0.76</td>
<td>0.80</td>
</tr>
<tr>
<td>Difference</td>
<td>0.0%</td>
<td>1.5%</td>
<td>1.4%</td>
<td>1.3%</td>
<td>0.9%</td>
</tr>
<tr>
<td>Labor force participation</td>
<td>0.88</td>
<td>0.77</td>
<td>0.71</td>
<td>0.72</td>
<td>0.88</td>
</tr>
<tr>
<td>Difference</td>
<td>2.0%</td>
<td>2.7%</td>
<td>3.3%</td>
<td>2.5%</td>
<td>0.8%</td>
</tr>
<tr>
<td>Children</td>
<td>0.99</td>
<td>1.39</td>
<td>1.60</td>
<td>1.20</td>
<td>0.58</td>
</tr>
<tr>
<td>Difference</td>
<td>-10%</td>
<td>-7%</td>
<td>-7%</td>
<td>-4%</td>
<td>-7%</td>
</tr>
<tr>
<td><strong>C. House prices as in 1990</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Homeownership rate</td>
<td>0.42</td>
<td>0.57</td>
<td>0.65</td>
<td>0.70</td>
<td>0.75</td>
</tr>
<tr>
<td>Difference</td>
<td>-0.5%</td>
<td>-1.8%</td>
<td>-2.9%</td>
<td>-4.2%</td>
<td>-4.3%</td>
</tr>
<tr>
<td>Labor force participation</td>
<td>0.86</td>
<td>0.75</td>
<td>0.69</td>
<td>0.70</td>
<td>0.88</td>
</tr>
<tr>
<td>Difference</td>
<td>0.2%</td>
<td>0.4%</td>
<td>0.7%</td>
<td>0.7%</td>
<td>0.5%</td>
</tr>
<tr>
<td>Children</td>
<td>1.08</td>
<td>1.48</td>
<td>1.70</td>
<td>1.23</td>
<td>0.61</td>
</tr>
<tr>
<td>Difference</td>
<td>0%</td>
<td>-1%</td>
<td>-1%</td>
<td>-2%</td>
<td>-2%</td>
</tr>
<tr>
<td><strong>D. Higher interest rate</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Homeownership rate</td>
<td>0.46</td>
<td>0.65</td>
<td>0.74</td>
<td>0.79</td>
<td>0.83</td>
</tr>
<tr>
<td>Difference</td>
<td>3.4%</td>
<td>6.3%</td>
<td>5.9%</td>
<td>4.4%</td>
<td>3.4%</td>
</tr>
<tr>
<td>Labor force participation</td>
<td>0.86</td>
<td>0.71</td>
<td>0.61</td>
<td>0.62</td>
<td>0.82</td>
</tr>
<tr>
<td>Difference</td>
<td>-0.7%</td>
<td>-3.6%</td>
<td>-6.8%</td>
<td>-7.5%</td>
<td>-5.6%</td>
</tr>
<tr>
<td>Children</td>
<td>1.12</td>
<td>1.59</td>
<td>1.89</td>
<td>1.40</td>
<td>0.72</td>
</tr>
<tr>
<td>Difference</td>
<td>3%</td>
<td>7%</td>
<td>10%</td>
<td>12%</td>
<td>15%</td>
</tr>
</tbody>
</table>